

FORM PTO-1390 (REV. 5-93)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER NIT-276
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)			
International Application No. PCT/JP98/04560	International Filing Date October 9, 1998	Priority Date Claimed	
Title of Invention CAPILLARY ELECTROPHORESIS SYSTEM, SAMPLE ANALYZING SYSTEM, AND SAMPLE CASSETTE			
Applicant(s) for DO/EO/US A. HIRABAYASHI et al (see attached)			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<p>1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</p> <p>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))</p> <ol style="list-style-type: none"> <li><input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</li> <li><input checked="" type="checkbox"/> has been transmitted by the International Bureau.</li> <li><input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> <p>6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <ol style="list-style-type: none"> <li><input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li><input type="checkbox"/> have been transmitted by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li><input type="checkbox"/> have not been made and will not be made.</li> </ol> <p>8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p>* Items 11. to 16. below concern other document(s) or information included:</p> <p>11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13. <input type="checkbox"/> A FIRST preliminary amendment.</p> <p><input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>14. <input type="checkbox"/> A substitute specification.</p> <p>15. <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>16. <input checked="" type="checkbox"/> Other items or information:</p> <p>[x] LIST OF INVENTORS' NAMES AND ADDRESSES.</p>			

U.S. Application No. 09/806913

International Application No.  
PCT/JP98/04560Attorney's Docket Number  
NIT-27617.  The following fees are submitted:Basic National Fee (37 CFR 1.492 (a)(1)-(5)):

Search Report has been prepared by the EPO or JPO ..... \$860.00  
 International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... \$690.00  
 No international preliminary examination fee (37 CFR 1.482)  
 but international search fee paid to USPTO (37 CFR 1.445 (A)(2)) ..... \$710.00  
 Neither international examination fee (37 CFR 1.482) nor  
 international search fee (37 CFR 1.445(A)(2)) paid to USPTO ..... \$1000.00  
 International preliminary examination fee paid to USPTO (37 CFR 1.482)  
 and all claims satisfied provisions of PCT Article 33(2) to (4) ..... \$100.00

CALCULATIONS

PTO USE ONLY

ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than  20  30 months from the earliest claimed priority date (37 CFR 1.492(e)). + \$ 0.00

Claims	Number Filed	Number Extra	Rate
Total	19	-20 = 0	x \$18.00 \$ 0.00
Independent	8	- 3 = 5	x \$80.00 \$ 400.00
Multiple dependent claim(s) (if applicable)			+ \$270.00 \$ 0.00

TOTAL OF ABOVE CALCULATIONS = \$ 1,260.00

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement  
 I must also be filed. (Note 37 CFR 1.9, 1.27, 1.28). + \$ 0.00

SUBTOTAL = \$ 1,260.00

Processing fee of \$130.00 for furnishing the English translation later than  20  30 months from the earliest claimed priority date (37 CFR 1.492(f)). + \$ 0.00

TOTAL NATIONAL FEE = \$ 1,260.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be  
 accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property. + \$ 0.00

TOTAL FEES ENCLOSED = \$ 1,260.00

Amount to be:

Refunded \$

Charged \$

a.  A check in the amount of \$ 1,260.00 to cover the above fees is enclosed.b.  Please charge my Deposit Account No. 50-1417 in the amount of \$ \_\_\_\_\_ to cover the above fees.  
 A duplicate copy of this sheet is enclosed.c.  The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any  
 overpayment to Deposit Account No. 50-1417. A duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive  
 (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

MATTINGLY, STANGER & MALUR, P.C.  
 104 East Hume Avenue  
 Alexandria, Virginia 22301  
 (703) 684-1120



Signature

John R. Mattingly

Name

30,293

Registration Number



24956

PATENT TRADEMARK OFFICE

09/806913

JC02 Rec'd PCT/PTO 06 APR 2001

NIT-276  
NT0342US

Title of the Invention

CAPILLARY ELECTROPHORESIS SYSTEM, SAMPLE  
ANALYZING SYSTEM, AND SAMPLE CASSETTE

Inventors

Atsumu HIRABAYASHI,

Yukiko HIRABAYASHI,

Akihiko OKUMURA,

Hideaki KOIZUMI.

CAPILLARY ELECTROPHORESIS SYSTEM,  
SAMPLE ANALYZING SYSTEM AND SAMPLE CASSETTE

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to a capillary electrophoresis system, sample analyzing system and sample cassette, and more particularly to a capillary electrophoresis system suitable to be connected to a sample analyzing system such as a mass spectrometer.

10 Description of the Prior Art

A capillary electrophoresis system having fine passages defined in a fused-silica wafer is well known in the art as described in "Analytical Chemistry", vol. 65, pp. 2637 - 2642 (1993).

15 Passages cited in this paper are constituted of an inlet passage for introducing liquid sample and a passage for electrophoresis that is perpendicularly defined to the inlet passage. The size of cross-section of these passages may be approximately 12 micrometers in depth, 50 micrometers in width, and 30 millimeters in length.

20 At the ends of passages, electrodes are provided. Every passages are filled with buffer solution first and liquid sample is injected at one end of the sample inlet passage. Thereafter 25 the liquid sample is introduced into the passage by applying

a voltage at the level of approximately few kilovolts between the electrodes placed at the both ends of sample inlet passages, whereby the introduction of liquid sample into the passage for electrophoresis completes. By applying a voltage of  
5 approximately few kilovolts to the electrodes placed at the both ends of the passages for electrophoresis the liquid sample introduced to the passage is separated by the electrophoresis phenomenon. The time required for the separation is approximately 10 seconds.

#### SUMMARY OF THE INVENTION

The capillary electrophoresis system of the Prior Art as have been described above has an advantage that it can separate one sample in a relatively short time. However, such a system needs to perform a cleaning procedure of the electrophoresis passages or to replace the fused-silica wafer with a new one. As a result, in order to perform a series of specimens sequentially, a considerable labor and time are required.

In addition, the capillary electrophoresis system of the  
20 Prior Art as have been described above may need to introduce the liquid sample directly onto the wafer. Since the sample inlet on the wafer is very fine and there are electrodes to which a high voltage is applied, the introduction of sample requires the operator to perform a complex work.

25 The present invention has been made in view of the above

circumstances and has an object to overcome the above problems.

An object of the present invention is to provide a capillary electrophoresis system and a sample analyzing system capable of analyzing a plurality of samples in a relatively short time.

5 Another object of the present invention is to provide a capillary electrophoresis system, which facilitates to clean the passages and has passages for repetitive use.

Still another object of the present invention is to provide a capillary electrophoresis system and a sample cassette for electrophoresis capable to carry a sample loaded therein.

To achieve the objects and in accordance with the purpose of the invention, as embodied and broadly described herein, this invention comprises a capillary electrophoresis system, having a wafery part having passages to flow liquid sample; and a body having a configuration so as to move the wafery part to setting in a relative manner. The body includes first and second electrodes for applying a voltage across both ends of passages of the wafery part to separate the sample solution and first and second buffer reservoirs conductive to the passages of the 20 wafery part at a specific position for filling buffer solution around the first and second electrodes.

In addition, the present invention provides a capillary electrophoresis system, comprising: a cartridge-type wafery part including a plurality of passages, a body having a buffer reservoir 25 conductive to the passages of wafery part, for maintaining the

wafery part in a removable and setting configuration.

In addition, in accordance with the present invention, during analysis, liquid sample will be loaded into the plurality of passages provided on the cartridge-type wafery part, then the wafery part is attached to the capillary electrophoresis system, then the liquid sample will be electrophoretically separated by relatively moving the wafery part having the liquid sample loaded with the capillary electrophoresis system to performing a separation of several kinds of materials in the liquid sample into bands.

As a result, separation of each sample, or separation for obtaining an electrophoresis migration time pattern of a single sample may be completed in a shorter time. Consequently a complex operation for introducing samples will be eliminated.

In addition, the present invention provides a liquid sample cassette for use in an electrophoresis separation comprising a wafery part having passages fulfilled with a solution, attached to a removable holder.

In addition, the present invention provides a sample analyzing system comprising a capillary electrophoresis system and an analyzer. The capillary electrophoresis system includes a wafery part having passages for flowing a solution, a body having a structure for relatively moving the wafery part in setting by maintaining the wafery part in a removable configuration.

The body further comprises: first and second electrodes for

applying a voltage across the passages in the wafery part to perform an electrophoresis separation to extract the solution through an end; and first and second buffer solution reservoir conductive to the solution in the passages in the wafery part at a specific position for fulfilling buffer solution on and around both the first and second electrodes. The analyzer optically detects the solution having electrophoresis separation performed by the capillary electrophoresis system to analyze.

In addition, the present invention provides a sample analyzing system comprising a capillary electrophoresis system, an ion source, and a mass spectrometer. The capillary electrophoresis system includes a wafery part having passages for flowing a liquid solution, and a body having a structure suitable for maintaining the wafery part in a removable configuration and for relatively moving the wafery part in a setting configuration. The body includes first and second electrodes for applying a voltage across both ends of passages of the wafery part to extract a solution from one end by electrophoresis separation, and first and second buffer reservoirs conductive to the solution in the wafery part at a specific position, for fulfilling buffer solution on and around the first and second electrodes. The ion source is connected to one of buffer reservoirs in the capillary electrophoresis system to ionize the solution flowing through the wafery part into gaseous ions. The mass spectrometry performs mass analyses

10  
15  
20

of the ions produced by the ion source.

The above and further objects and novel features of the present invention more fully appear from following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and not intended as a definition of the limits of the present invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional view in a direction of wafery part, illustrating a first embodiment of wafery part in accordance with the present invention;

Fig. 2A is a schematic cross-sectional view in the vertical direction before attaching the wafery part of the first embodiment of capillary electrophoresis system of the present invention into the system;

Fig. 2B is a schematic cross-sectional view in the vertical direction illustrating buffer reservoirs fulfilled with buffer solution and wafery part attached to the body in the first embodiment of capillary electrophoresis system in accordance with the present invention;

Fig. 3 is a top view of the first embodiment of capillary electrophoresis system in accordance with the present invention;

Fig. 4 is a top view showing a second embodiment of the

wafery part in accordance with the present invention;

Fig. 5 is a schematic cross-sectional view in the vertical direction illustrating a capillary electrophoresis system connected to an ion source of a mass spectrometer in accordance with the present invention;

Fig. 6 is an electrophoresis sample cassette with a wafery part attached in a removable holder in accordance with the present invention;

Fig. 7 is a top view of the second embodiment of capillary electrophoresis system in accordance with the present invention; and

Fig. 8 is a graph showing an electrophoresis pattern.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A detailed description of one preferred embodiment embodying the present invention is now given referring to the accompanying drawings.

Now referring to Fig. 1, there is shown a schematic cross-sectional view in the direction of wafery part of first embodiment of a cartridge-type wafery part 1. The cartridge-type wafery part 1 may be formed from a dielectric material such as quartz glass or a resin.

On the wafery part 1 there are provided a plurality of passages 2 each having the same shape in their profile. The sectional area of the passages 2 may be equal to or less than

10  
11  
12  
13  
14  
15  
16  
17  
18

20

25

100 micrometers, and in a typical embodiment the passages 2 may be formed in a rectangle of the size of 10 micrometers by 60 micrometers.

5 It may be advantageous for producing a wafery part 1 having a plurality of passages 2 as have been described above by bonding a plate having channels with another plate. To process the channels a dry etching technology may be applicable. The wafery part may also be made by embedding a fused-silica capillary having inner diameter of less than 50 micrometers into channels.

10 As shown in Fig. 1, the passages 2 (or capillaries) are fulfilled with a liquid solution. Because of the fine cross-sectional area of passages 2 the solution is likely to be sucked therein due to the capillarity, so that the solution thereby will fill the passages 2 easily. However, if needed the solution may be loaded by means of a forced suction.

15 To perform a capillary electrophoresis system, buffer solution 22 (any desired buffer solution may be used, including PBS) are preloaded into the passages 2 (or capillaries). Then, a liquid sample 21 containing a variety of materials is loaded 20 through one end of the passages 2 (or capillaries). In the liquid sample 21, charged particles (ionized particles) and neutralized molecules may be contained in general. Then, as shown in Fig. 2B and Fig. 3, a high voltage is applied across both ends of the passages 2 (capillaries) to effectuate an electrophoresis 25 separation. In order to make a good electrical contact, the

electrodes 6 and 7 for applying the voltage are dipped into a conductive solution 23 such as the buffer solution as well as the terminus of capillary.

In Fig. 1, the liquid sample 21 is illustrated as liquid drops falling from the top, and the solution filled in the passages 2 is the buffer solution 22. In Fig. 2, the liquid sample 21 is in the leftmost part of the passages 2 and other part is filled with the buffer solution 22 and 23.

To fill the buffer solution 22 in the passages 2 (in the capillaries) of the wafery part 1, the capillarity phenomenon may be used. However, a syringe may also be used for pumping or sucking. Then the liquid sample 21 is to be loaded by making use of gravitational suction or electrophoresis suction.

The volume of the liquid sample 21 may differ depending on the operation technique for suction. For example, in the gravity method the flow rate of the liquid sample sucked may be precalculated, so that the volume of the liquid sample 21 can be determined by controlling the duration of suction time. In cases in accordance with the present invention, the use of gravity method and electrophoresis method has not a significant advantage when compared to the use of other methods. Indeed the suction by using a pump or a syringe may rather be convenient. In such a case the volume of the liquid sample 21 to be sucked can be measured by the syringe used to determine the volume of the sucked liquid sample 21. The cross-sectional area of the

5        passages 2 (or capillaries) is very fine and known, so that the liquid sample 21 contained in the capillary have approximately 1 millimeter in length. The volume of the sucked liquid sample 21 can be determined by measuring the length of either the buffer solution 22 or the liquid sample 21 in condition that the buffer solution 22 can be distinguished from the liquid sample 21.

10        As can be appreciated from the foregoing description, since the liquid sample 21 can be introduced in a easy way into a plurality of passages 2 (or capillaries) of the wafery part 1, as well as since the wafery part 1 can be detached from the capillary electrophoresis system device in order to rinse the passages 2, the wafery part 1 may be suitable for reuse.

15        Now referring to Fig. 2, there is shown a schematic cross-sectional view in the vertical direction of the first embodiment of the capillary electrophoresis system in accordance with the present invention. Fig. 2A is a schematic diagram immediately before the wafery part 1 is attached to the device 3, while Fig. 2B is the wafery part 1 attached to the device 3. As shown in Fig. 2A, the wafery part 1 having a fluid containing 20        the liquid sample 21 and the buffer solution 22 introduced into a plurality of passages 2 being attached (mounted) to the device 3 of the capillary electrophoresis system as shown in Fig. 2B. The device 3 is made of a dielectric material such as a fused silica and a resin, as similar to the wafery part 1. On the 25        device 3 there are provided a first buffer reservoir 4 and a

second buffer reservoir 5. As shown in Fig. 2B, the conductive solution 23 is poured into the first buffer reservoir 4 and the second buffer reservoir 5 after attaching the wafery part 1 to the device 3 in order to prevent any bubbles from being introduced 5 into the passages 2 of the wafery part 1.

Each of the first buffer reservoir 4 and the second buffer reservoir 5 of the device 3 of capillary electrophoresis system have a first electrode 6 and a second electrode 7 respectively, through which electrodes a voltage will be applied through the first electrode 6 and the second electrode 7 to the conductive buffer solution 23 to ultimately the liquid sample 21 in the passages 2 (or capillaries) in order to perform an electrophoresis separation.

On or near the first electrode 6 and the second electrode 7 the buffer solution 23 may develop gases, which may form bubbles. When such bubbles may be in the passages 2 the electrophoresis will malfunction. Therefore a path 4a and a path 5a above the first electrode 6 and the second electrode 7 will be provided for respective the first buffer reservoir 4 and the second buffer 20 reservoir 5, both of paths communicating respective reservoirs into the ambient air. The buffer solution 23 contained in the first buffer reservoir 4 and the second buffer reservoir 5 may be in direct contact with the ambient air so that through these paths 4a and 5a it will be capable of releasing bubbles developed 25 in the fluid to the environment.

By monitoring the electrophoresis current the bubbles aberrant into the passages 2 can also be detected.

As shown in Fig. 2B, one ends of both the first electrode 6 and the second electrode 7 are in direct contact with the buffer solution 23. In order to protect the operator from electric shock, the terminus of the first electrode 6 and the second electrode 7 in contact with the buffer solution 23 may be shielded so as to minimize the exposed part toward the wafery part 1. This may help installing any wires and circuitry for the high voltage application beneath the wafery part 1.

On the other hand, the other terminus of the first electrode 6 and the second electrode 7 are in contact with the ambient air and will be applied with a voltage. The voltage application may be convenient in such a way that the first electrode 6 should be connected to a voltage potential HV while the second electrode 7 to the earth potential.

Since a voltage will be applied between the first electrode 6 and the second electrode 7, an electroosmosis flow will be developed therebetween to move the entire liquid sample 21 in the passages 2 toward the second electrode 7. At the same time the fluid will undergo with an electrophoresis separation, several kinds of materials which are contained in the liquid sample 21 will be separated into bands. More specifically, an electroosmosis flow makes move of the liquid sample 21 in the capillaries 2 at a certain rate of flow, and specimen materials

(charged particles or ions and neutral molecules and the like) contained in the liquid sample 21 to be moved are separated each from other by their mobility difference. As a result fluid containing isolated sample matter resides at some points along 5 the capillaries 2, making several bands of sample material isolated from within the solution. After some times the bands isolated each from other reach to the very end of the capillaries 2, ultimately in sequence.

10 11 12 13 14 15

20

Sample molecules separated into bands as have been described above may be detected in an optical method, by using an optical microscope or a confocal microscope to video-record. More specifically, the optical detection methods include a method of labeling the sample molecules isolated into bands with fluorescent marker to visualize the sample material (isolated sample molecules) by means of fluorescent detection by laser excitation. This method is such that the fluorescence light emitted from the sample molecules isolated into bands is detected by a photomultiplier tube or a CCD (charge coupled device) camera. When the observation region obtained as an image by the CCD camera 20 is vast, a plurality of capillaries (passages) 2 are observed simultaneously to enable optical analysis of the liquid sample.

25

A packing 8 is interposed between the wafery part 1 and the device 3 of the capillary electrophoresis system for the purpose of watertight seal. When the packing 8 is broken the buffer solution may flow out to the bottom of the wafery part

1. In such a case the first electrode 6 and the second electrode 7 will be conducted through the effluent buffer to make a short circuit. This problem may be avoided by providing a liquid reservoir 3a on the device 3.

5 Now referring to Fig. 3, there is shown an overview of the first embodiment of capillary electrophoresis system shown in Fig. 1 viewed from the topside. The wafery part 1 will be displaced in stepwise in the horizontal direction (direction of the drawing plane) by means of a stepping motor and the like. In the embodiment shown in Fig. 3, the wafery parts 1 are placed separated apart each from another at a regular interval. By moving one channel at a time by an even distance at every regular intervals, a voltage will be applied across the first electrode 6 and the second electrode 7 to form an electroosmosis flow in one capillary, so that the liquid sample 21 contained in one capillary (passages) 2 will be moved toward the second electrode 7, then at the same time to isolate by the electrophoresis several kinds of materials contained in the liquid sample 21 into bands. Those materials (sample molecules) isolated into bands may be 20 analyzed in such a way as by optical analysis such as the fluorescence light detection or optical density (OD) measurement as have been described above, or by transforming into gaseous ions by the sonic splay ionization technique to be analyzed in a mass spectrometer installed in a vacuum chamber.

25 To achieve the analysis, in the structural aspect, the

first buffer reservoir 4 and the second buffer reservoir 5 are tailored to be smaller than the interval between passages 2 so as to communicate at each moving distance of the wafery part 1 to at most one passage 2.

5 In the temporal aspect, in the electrophoresis, an analytical session may last in approximately 20 seconds. Therefore the wafery part 1 may move every 20 seconds. To protect against electrical leak, it is preferable to abort the voltage application to the first electrode 6 and the second electrode 7 during moving the wafery part 1.

Now referring to Fig. 4, there is shown a schematic diagram illustrating the second embodiment of the wafery part 1 having passages 2 in accordance with the present invention. In the second preferred embodiment, the interval between passages 2 at the inlet of the liquid sample at the left side is larger than the interval of passages 2 at the right side. In other words the distance between passages 2 in the sample inlet at the left side is set to be 2 millimeters or more to facilitate the loading of liquid sample, while the distance between passages 2 of the detector side at the right hand is made smaller to facilitate the displacement of entire range by means of a precise position adjuster.

20 To assure the repeatability of electrophoresis, the shape of passages 2 will be tailored such that all passages 2 has the same length.

The volume of sample solution to be loaded into the passages 2 may be approximately 10 nanolitters, implicitly requiring a high sensitivity instrument for detecting the isolated matters, such as a mass spectrometer.

Now referring to Fig. 5, there is shown a schematic cross-sectional view in the vertical direction of a capillary electrophoresis system connected to an ion source of a mass spectrometer MS in accordance with the present invention. In this preferred embodiment, the matters in the liquid sample isolated by an electrophoresis assay, are transformed into gaseous ions by the sonic splay ionization technique to feed to the mass spectrometer MS installed in a vacuum chamber to analyze and determine the mass of ions. Ionization in the ion source 9 may be also effectuated by such methods as atmospheric pressure chemical ionization, electrospray ionization, and however these methods may restrict the composition of buffer solution. More specifically, in another ionization such as electrospray ionization method, ions cannot be generated in a stable manner from a solution having a high electric conductivity 20 such as the PBS.

The analyzer for analyzing several kinds of material (sample molecules) to be isolated may be a spectrofluorometer, optical density spectrometer, and electrode spectrometry rather than the mass spectrometry MS.

In the system shown in Fig. 5, the mixture (a liquid sample

containing several matters) can be isolated and analyzed rapidly. In the ion source 9 for transforming the liquid sample into gaseous ions, the liquid sample 21 containing several matters (sample molecules) isolated by the electrophoresis is sprayed with a sonic gas flow (the sonic splay ionization). The detailed discussion on the sonic splay ionization can be seen in the "Trends in Analytical Chemistry", Vol. 16, pp. 45 - 52 (1997).

As shown in Fig. 5, the structure of the ion source 9 is just like a nebulizer. The liquid sample isolated by the electrophoresis by the electroosmosis flow will be loaded into the silica capillary 10 having an inner diameter of approximately 50 micrometers. One end of capillary 10 is inserted into an orifice 11 of the ion source 9.

Nitrogen gas is introduced from the above into the ion source 9 to release the gas to the environment through the orifice 11 at the sonic speed. The sample solution loaded into the capillary 10 is ionized by the sonic gas flow. The gaseous ions generated in the ambient air are captured into the vacuum chamber to perform a mass analysis by means of a mass spectrometer MS 20 not shown in the figure but installed in the vacuum chamber.

The solution loaded in the capillary 10 is sucked by the sonic gas flow. The flow rate of sucked flow may be higher than the flow rate of electroosmosis flow in the passages 2. Therefore, to avoid this, the ends of the passages 2 are placed at a very narrow distance to the capillary 10 of one millimeter or less

so as not to directly connect to the capillary 10. In this arrangement the exact amount required of buffer solution in the second buffer reservoir 5 is sucked into the capillary 10 while preventing the liquid sample 21 in the passages 2 from being spilled out in order not to affect the electrophoresis via one end of the passages 2.

In the above configuration, the center axis of outlet passages 2 and the inlet capillary 10 need to be aligned as precise as possible. If there is a significant offset therebetween part of solution spilled from the passages 2 may not be directed into the capillary 10 to cause a problem of sensitivity of detection and a repeatability.

The voltage to be applied in the system shown in Fig. 5 will be such that the potential of the second electrode 7 is set to the ground potential while a high voltage HV of approximately 3 kilovolts for electrophoresis is applied to the first electrode 6. In addition if another voltage HVI of approximately 1.2 kilovolts is applied to the ion source 9, a large quantity of ions comprised of the materials in the sample solution charged to a potential opposite to the polarity of the voltage will be generated. The polarity of the voltage applied to the ion source 9 can be selectable depending on the ion potential of the materials to be detected.

The wafery part 1 may also be used for the purpose of sample introduction by introducing only the liquid sample 21 into the

passages 2 (capillaries) of the wafery part 1. In this case, the buffer solution does not be introduced to the wafery part 1.

Now referring to Fig. 6, there is shown a schematic diagram 5 in which the wafery part 1 for capillary electrophoresis system in accordance with the present invention is removably attached to a sample holder 11. In a combination of capillary electrophoresis with a mass spectrometry (CE/MS) as shown in Fig. 5, the installation may become large. Therefore the liquid sample 21 may be conveniently prepared to introduce into the passages 2 (capillaries) of the wafery part 1 so as to carry wafery part 1 attached to a sample holder 11. More specifically, the wafery part 1 having passages 2 (capillaries) having liquid sample 21 introduced for the capillary electrophoresis system in accordance with the present invention can be removably attached to a sample holder 11. The solution 21 and 22 in the very fine structure being loaded in the passages 2 (capillaries) of the wafery part 1 to be removably attached to the sample holder 11 are unlikely to be intermixed so that there is not a problem 20 of transportation for a while. By watertightly sealing the liquid sample 21 and 22 in the sample holder 11 the evaporation of samples 21 and 22 can be prevented.

The tolerable time to load the sample into the capillary electrophoresis system device 3 can be prolonged by freezing 25 the wafery part 1 together with the sample solution 21 loaded

in the sample holder 11.

The sample holder 11 may be preferable made of a fluoroplastic resin, which may absorb scarcely matters.

As can be appreciated from the foregoing description, as shown in Fig. 6, a sample cassette for electrophoresis separation that houses the sample holder 11 in which is removably attached (inserted) the wafery part 1 having passages 2 (capillaries) containing the liquid sample solution 21 allows carrying samples to the capillary electrophoresis system device 3.

Now referring to Fig. 7, there is shown a plan view of a second embodiment of the capillary electrophoresis system suitable for the separation of one sample solution in accordance with the present invention. In the second preferred embodiment, the liquid sample 21 in a plurality of passages 2 can be electrophoresis separated because the first buffer reservoir 4 and the second buffer reservoir 5 are enlarged. More specifically, the solution 21 and 22 in a plurality of passages 2 (capillaries) are applied with a voltage, so that the liquid sample 21 in the passages 2 (capillaries) can be electrophoresis separated. The starting time of separation of respective liquid sample 21 in each of the passages 2 can be shifted in accordance with moving in either a continuous or a stepwise manner the wafery part 1 and shifting the timing of applying the voltage thereto to shift the starting time of electrophoresis. More specifically, as a passage (capillary) 2a is to be first applied with a voltage,

the sample solution 21 in the passage (capillary) 2a can be first electrophoresis separated. Then followed by the capillary 2a, a voltage is applied to another passage (capillary) 2b, so that the liquid sample 21 in the capillary 2b can be second electrophoresis separated. In this manner, stepwise or continuous movement of the wafery part 1 may cause the starting time of electrophoresis to be delayed by shifting the applying timing of voltage to allow the starting time of electrophoresis for each of liquid samples 21 in the passages 2 to be shifted each other.

10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95

Now referring to Fig. 8 there is an exemplary graph illustrating an electrophoresis result obtained by the separation of one single liquid sample 21 as shown in Fig. 7. The ordinate (y-axis) indicates the absorbance of the solution separated, and the abscissa indicates the migration time. Peaks in Fig. 8 denote to the presence of matters. Before approximately 2 seconds from the start of electrophoresis, there is not appeared a peak. This indicates that the 2 seconds at the start of electrophoresis has no significance in observation.

Furthermore, when analyzing the concentration of a specific matter, it is sufficient to detect the peak of that matter only when that peak appears in the electrophoresis pattern. Any other observation may be useless. Therefore, it is convenient to shift the starting time of electrophoresis separation of the liquid sample 21 as shown in Fig. 5 if a number of samples 21 need to

be analyzed in a period of time as short as possible. In addition, if it is sufficient to detect only one specific matter, the analysis can be completed at the speed of one sample per second since the time required for analyzing one liquid sample is 5 approximately 1 second.

In accordance with the capillary electrophoresis system of the present invention, a plurality of samples may be completed to be analyzed in a shorter time.

Since the liquid sample 21 is introduced into a cartridge-type wafery part 1, the wafery part 1 can be carried with the sample loaded therein. The wafery part 1 may be rinsed easily and can be iteratively reused.

10 15 20 25

20

25

The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description thereof. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiments chosen and described herein in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

## WHAT IS CLAIMED IS:

1. A capillary electrophoresis system, comprising:

a wafery part having passages for introducing sample solutions; and

5 a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, wherein said body includes,

first and second electrodes for applying a voltage between both ends of passages of said wafery part to separate and take out said sample solution from one end, and

first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes.

2. A capillary electrophoresis system according to claim 1, wherein said wafery part is made of a dielectric material.

3. A capillary electrophoresis system according to claim 1, wherein said wafery part is interchangeable with said passage filled with a solution.

4. A capillary electrophoresis system according to claim 20 1, wherein a plurality of said passages are provided in said wafery part.

5. A capillary electrophoresis system according to claim 4, wherein said passages are formed in said wafery part at an even interval at least in an end of passages.

25 6. A capillary electrophoresis system according to claim

4, wherein there is difference of starting time of flowing the solutions filled in said plurality of passages formed in said wafery part into either said first or second buffer solution reservoir.

5 7. A capillary electrophoresis system according to claim 4, wherein solutions filled in said plurality of passages formed in said wafery part sequentially flow into either said first or second buffer solution reservoir by displacing in a relative manner said wafery part with respect to said body.

8. A capillary electrophoresis system according to claim 1, wherein at least part of said wafery part is formed of a dielectric material.

9. A capillary electrophoresis system, comprising:  
a wafery part having passages filled with a buffer solution for introducing sample solutions together; and  
a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, wherein  
said body includes:

first and second electrodes for applying a voltage between  
20 both ends of passages of said wafery part to separate and take out said sample solution; and

first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes.

25 10. A capillary electrophoresis system according to claim

9, wherein said wafery part is made of a dielectric material.

11. A capillary electrophoresis system according to claim 9, wherein said wafery part is interchangeable with said passage filled with liquid sample and buffer solution.

5 12. A capillary electrophoresis system according to claim 9, wherein a plurality of said passages are provided in said wafery part.

13. A capillary electrophoresis system according to claim 12, wherein said passages are formed in said wafery part at an even interval at least in an end of passages.

14. A sample cassette for electrophoresis separation, comprising:

a carriable holder in which is inserted a wafery part having passages filled with a solution.

15. A sample analyzing system comprising:

a capillary electrophoresis system having a wafery part having passages for introducing a sample solution, and a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, in which said body includes first and second electrodes for applying a voltage across both ends of passages of said wafery part to separate and take out said sample solution, and first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes; and

an analyzer for optically detecting and analyzing the solution having electrophoresis separated by said capillary electrophoresis system.

16. A sample analyzing system comprising:

5 a capillary electrophoresis system having a wafery part having passages filled with buffer solution for introducing a sample solution, and a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, in which said body includes first and second electrodes for applying a voltage across both ends of passages of said wafery part to separate and take out said sample solution, and first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes; and

10 15 an analyzer for optically detecting and analyzing the solution having electrophoresis separated by said capillary electrophoresis system.

17. A sample analyzing system comprising:

20 a capillary electrophoresis system having a wafery part having passages for introducing a sample solution, and a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, in which said body includes first and second electrodes for applying a voltage across both ends of passages of said wafery part to separate and take out said sample solution, and first and second buffer

reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes;

an ion source connected to one of said buffer reservoirs of said capillary electrophoresis system for ionizing the solution spilled from said wafery part into gaseous ions; and

5 a mass spectrometer for performing mass analysis of the ions emitted from said ion source.

18. A sample analyzing system comprising:

a capillary electrophoresis system having a wafery part having passages for introducing a sample solution, and a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, in which said body includes first and second electrodes for applying a voltage across both ends of passages of said wafery part to separate and take out said sample solution, and first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes;

20 an ion source connected to one of said buffer reservoirs of said capillary electrophoresis system for ionizing the liquid sample solution isolated by electrophoresis from said wafery part into gaseous ions; and

25 a mass spectrometer for performing mass analysis of the ions emitted from said ion source.

19. A sample analyzing system comprising:  
a capillary electrophoresis system having a wafery part  
having passages filled with buffer solution for introducing a  
sample solution, and a body having a configuration suitable to  
5 removably hold and to move said wafery part attached in a relative  
manner, in which said body includes first and second electrodes  
for applying a voltage across both ends of passages of said wafery  
part to separate and take out said sample solution, and first  
and second buffer reservoirs conductive to said passages of said  
wafery part at a specific position for filling buffer solution  
around said first and second electrodes;

an ion source connected to one of said buffer reservoirs  
of said capillary electrophoresis system for ionizing the  
solution spilled from said wafery part into gaseous ions; and

20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150  
155  
160  
165  
170  
175  
180  
185  
190  
195  
200  
205  
210  
215  
220  
225  
230  
235  
240  
245  
250  
255  
260  
265  
270  
275  
280  
285  
290  
295  
300  
305  
310  
315  
320  
325  
330  
335  
340  
345  
350  
355  
360  
365  
370  
375  
380  
385  
390  
395  
400  
405  
410  
415  
420  
425  
430  
435  
440  
445  
450  
455  
460  
465  
470  
475  
480  
485  
490  
495  
500  
505  
510  
515  
520  
525  
530  
535  
540  
545  
550  
555  
560  
565  
570  
575  
580  
585  
590  
595  
600  
605  
610  
615  
620  
625  
630  
635  
640  
645  
650  
655  
660  
665  
670  
675  
680  
685  
690  
695  
700  
705  
710  
715  
720  
725  
730  
735  
740  
745  
750  
755  
760  
765  
770  
775  
780  
785  
790  
795  
800  
805  
810  
815  
820  
825  
830  
835  
840  
845  
850  
855  
860  
865  
870  
875  
880  
885  
890  
895  
900  
905  
910  
915  
920  
925  
930  
935  
940  
945  
950  
955  
960  
965  
970  
975  
980  
985  
990  
995  
1000  
1005  
1010  
1015  
1020  
1025  
1030  
1035  
1040  
1045  
1050  
1055  
1060  
1065  
1070  
1075  
1080  
1085  
1090  
1095  
1100  
1105  
1110  
1115  
1120  
1125  
1130  
1135  
1140  
1145  
1150  
1155  
1160  
1165  
1170  
1175  
1180  
1185  
1190  
1195  
1200  
1205  
1210  
1215  
1220  
1225  
1230  
1235  
1240  
1245  
1250  
1255  
1260  
1265  
1270  
1275  
1280  
1285  
1290  
1295  
1300  
1305  
1310  
1315  
1320  
1325  
1330  
1335  
1340  
1345  
1350  
1355  
1360  
1365  
1370  
1375  
1380  
1385  
1390  
1395  
1400  
1405  
1410  
1415  
1420  
1425  
1430  
1435  
1440  
1445  
1450  
1455  
1460  
1465  
1470  
1475  
1480  
1485  
1490  
1495  
1500  
1505  
1510  
1515  
1520  
1525  
1530  
1535  
1540  
1545  
1550  
1555  
1560  
1565  
1570  
1575  
1580  
1585  
1590  
1595  
1600  
1605  
1610  
1615  
1620  
1625  
1630  
1635  
1640  
1645  
1650  
1655  
1660  
1665  
1670  
1675  
1680  
1685  
1690  
1695  
1700  
1705  
1710  
1715  
1720  
1725  
1730  
1735  
1740  
1745  
1750  
1755  
1760  
1765  
1770  
1775  
1780  
1785  
1790  
1795  
1800  
1805  
1810  
1815  
1820  
1825  
1830  
1835  
1840  
1845  
1850  
1855  
1860  
1865  
1870  
1875  
1880  
1885  
1890  
1895  
1900  
1905  
1910  
1915  
1920  
1925  
1930  
1935  
1940  
1945  
1950  
1955  
1960  
1965  
1970  
1975  
1980  
1985  
1990  
1995  
2000  
2005  
2010  
2015  
2020  
2025  
2030  
2035  
2040  
2045  
2050  
2055  
2060  
2065  
2070  
2075  
2080  
2085  
2090  
2095  
2100  
2105  
2110  
2115  
2120  
2125  
2130  
2135  
2140  
2145  
2150  
2155  
2160  
2165  
2170  
2175  
2180  
2185  
2190  
2195  
2200  
2205  
2210  
2215  
2220  
2225  
2230  
2235  
2240  
2245  
2250  
2255  
2260  
2265  
2270  
2275  
2280  
2285  
2290  
2295  
2300  
2305  
2310  
2315  
2320  
2325  
2330  
2335  
2340  
2345  
2350  
2355  
2360  
2365  
2370  
2375  
2380  
2385  
2390  
2395  
2400  
2405  
2410  
2415  
2420  
2425  
2430  
2435  
2440  
2445  
2450  
2455  
2460  
2465  
2470  
2475  
2480  
2485  
2490  
2495  
2500  
2505  
2510  
2515  
2520  
2525  
2530  
2535  
2540  
2545  
2550  
2555  
2560  
2565  
2570  
2575  
2580  
2585  
2590  
2595  
2600  
2605  
2610  
2615  
2620  
2625  
2630  
2635  
2640  
2645  
2650  
2655  
2660  
2665  
2670  
2675  
2680  
2685  
2690  
2695  
2700  
2705  
2710  
2715  
2720  
2725  
2730  
2735  
2740  
2745  
2750  
2755  
2760  
2765  
2770  
2775  
2780  
2785  
2790  
2795  
2800  
2805  
2810  
2815  
2820  
2825  
2830  
2835  
2840  
2845  
2850  
2855  
2860  
2865  
2870  
2875  
2880  
2885  
2890  
2895  
2900  
2905  
2910  
2915  
2920  
2925  
2930  
2935  
2940  
2945  
2950  
2955  
2960  
2965  
2970  
2975  
2980  
2985  
2990  
2995  
3000  
3005  
3010  
3015  
3020  
3025  
3030  
3035  
3040  
3045  
3050  
3055  
3060  
3065  
3070  
3075  
3080  
3085  
3090  
3095  
3100  
3105  
3110  
3115  
3120  
3125  
3130  
3135  
3140  
3145  
3150  
3155  
3160  
3165  
3170  
3175  
3180  
3185  
3190  
3195  
3200  
3205  
3210  
3215  
3220  
3225  
3230  
3235  
3240  
3245  
3250  
3255  
3260  
3265  
3270  
3275  
3280  
3285  
3290  
3295  
3300  
3305  
3310  
3315  
3320  
3325  
3330  
3335  
3340  
3345  
3350  
3355  
3360  
3365  
3370  
3375  
3380  
3385  
3390  
3395  
3400  
3405  
3410  
3415  
3420  
3425  
3430  
3435  
3440  
3445  
3450  
3455  
3460  
3465  
3470  
3475  
3480  
3485  
3490  
3495  
3500  
3505  
3510  
3515  
3520  
3525  
3530  
3535  
3540  
3545  
3550  
3555  
3560  
3565  
3570  
3575  
3580  
3585  
3590  
3595  
3600  
3605  
3610  
3615  
3620  
3625  
3630  
3635  
3640  
3645  
3650  
3655  
3660  
3665  
3670  
3675  
3680  
3685  
3690  
3695  
3700  
3705  
3710  
3715  
3720  
3725  
3730  
3735  
3740  
3745  
3750  
3755  
3760  
3765  
3770  
3775  
3780  
3785  
3790  
3795  
3800  
3805  
3810  
3815  
3820  
3825  
3830  
3835  
3840  
3845  
3850  
3855  
3860  
3865  
3870  
3875  
3880  
3885  
3890  
3895  
3900  
3905  
3910  
3915  
3920  
3925  
3930  
3935  
3940  
3945  
3950  
3955  
3960  
3965  
3970  
3975  
3980  
3985  
3990  
3995  
4000  
4005  
4010  
4015  
4020  
4025  
4030  
4035  
4040  
4045  
4050  
4055  
4060  
4065  
4070  
4075  
4080  
4085  
4090  
4095  
4100  
4105  
4110  
4115  
4120  
4125  
4130  
4135  
4140  
4145  
4150  
4155  
4160  
4165  
4170  
4175  
4180  
4185  
4190  
4195  
4200  
4205  
4210  
4215  
4220  
4225  
4230  
4235  
4240  
4245  
4250  
4255  
4260  
4265  
4270  
4275  
4280  
4285  
4290  
4295  
4300  
4305  
4310  
4315  
4320  
4325  
4330  
4335  
4340  
4345  
4350  
4355  
4360  
4365  
4370  
4375  
4380  
4385  
4390  
4395  
4400  
4405  
4410  
4415  
4420  
4425  
4430  
4435  
4440  
4445  
4450  
4455  
4460  
4465  
4470  
4475  
4480  
4485  
4490  
4495  
4500  
4505  
4510  
4515  
4520  
4525  
4530  
4535  
4540  
4545  
4550  
4555  
4560  
4565  
4570  
4575  
4580  
4585  
4590  
4595  
4600  
4605  
4610  
4615  
4620  
4625  
4630  
4635  
4640  
4645  
4650  
4655  
4660  
4665  
4670  
4675  
4680  
4685  
4690  
4695  
4700  
4705  
4710  
4715  
4720  
4725  
4730  
4735  
4740  
4745  
4750  
4755  
4760  
4765  
4770  
4775  
4780  
4785  
4790  
4795  
4800  
4805  
4810  
4815  
4820  
4825  
4830  
4835  
4840  
4845  
4850  
4855  
4860  
4865  
4870  
4875  
4880  
4885  
4890  
4895  
4900  
4905  
4910  
4915  
4920  
4925  
4930  
4935  
4940  
4945  
4950  
4955  
4960  
4965  
4970  
4975  
4980  
4985  
4990  
4995  
5000  
5005  
5010  
5015  
5020  
5025  
5030  
5035  
5040  
5045  
5050  
5055  
5060  
5065  
5070  
5075  
5080  
5085  
5090  
5095  
5100  
5105  
5110  
5115  
5120  
5125  
5130  
5135  
5140  
5145  
5150  
5155  
5160  
5165  
5170  
5175  
5180  
5185  
5190  
5195  
5200  
5205  
5210  
5215  
5220  
5225  
5230  
5235  
5240  
5245  
5250  
5255  
5260  
5265  
5270  
5275  
5280  
5285  
5290  
5295  
5300  
5305  
5310  
5315  
5320  
5325  
5330  
5335  
5340  
5345  
5350  
5355  
5360  
5365  
5370  
5375  
5380  
5385  
5390  
5395  
5400  
5405  
5410  
5415  
5420  
5425  
5430  
5435  
5440  
5445  
5450  
5455  
5460  
5465  
5470  
5475  
5480  
5485  
5490  
5495  
5500  
5505  
5510  
5515  
5520  
5525  
5530  
5535  
5540  
5545  
5550  
5555  
5560  
5565  
5570  
5575  
5580  
5585  
5590  
5595  
5600  
5605  
5610  
5615  
5620  
5625  
5630  
5635  
5640  
5645  
5650  
5655  
5660  
5665  
5670  
5675  
5680  
5685  
5690  
5695  
5700  
5705  
5710  
5715  
5720  
5725  
5730  
5735  
5740  
5745  
5750  
5755  
5760  
5765  
5770  
5775  
5780  
5785  
5790  
5795  
5800  
5805  
5810  
5815  
5820  
5825  
5830  
5835  
5840  
5845  
5850  
5855  
5860  
5865  
5870  
5875  
5880  
5885  
5890  
5895  
5900  
5905  
5910  
5915  
5920  
5925  
5930  
5935  
5940  
5945  
5950  
5955  
5960  
5965  
5970  
5975  
5980  
5985  
5990  
5995  
6000  
6005  
6010  
6015  
6020  
6025  
6030  
6035  
6040  
6045  
6050  
6055  
6060  
6065  
6070  
6075  
6080  
6085  
6090  
6095  
6100  
6105  
6110  
6115  
6120  
6125  
6130  
6135  
6140  
6145  
6150  
6155  
6160  
6165  
6170  
6175  
6180  
6185  
6190  
6195  
6200  
6205  
6210  
6215  
6220  
6225  
6230  
6235  
6240  
6245  
6250  
6255  
6260  
6265  
6270  
6275  
6280  
6285  
6290  
6295  
6300  
6305  
6310  
6315  
6320  
6325  
6330  
6335  
6340  
6345  
6350  
6355  
6360  
6365  
6370  
6375  
6380  
6385  
6390  
6395  
6400  
6405  
6410  
6415  
6420  
6425  
6430  
6435  
6440  
6445  
6450  
6455  
6460  
6465  
6470  
6475  
6480  
6485  
6490  
6495  
6500  
6505  
6510  
6515  
6520  
6525  
6530  
6535  
6540  
6545  
6550  
6555  
6560  
6565  
6570  
6575  
6580  
6585  
6590  
6595  
6600  
6605  
6610  
6615  
6620  
6625  
6630  
6635  
6640  
6645  
6650  
6655  
6660  
6665  
6670  
6675  
6680  
6685  
6690  
6695  
6700  
6705  
6710  
6715  
6720  
6725  
6730  
6735  
6740  
6745  
6750  
6755  
6760  
6765  
6770  
6775  
6780  
6785  
6790  
6795  
6800  
6805  
6810  
6815  
6820  
6825  
6830  
6835  
6840  
6845  
6850  
6855  
6860  
6865  
6870  
6875  
6880  
6885  
6890  
6895  
6900  
6905  
6910  
6915  
6920  
6925  
6930  
6935  
6940  
6945  
6950  
6955  
6960  
6965  
6970  
6975  
6980  
6985  
6990  
6995  
7000  
7005  
7010  
7015  
7020  
7025  
7030  
7035  
7040  
7045  
7050  
7055  
7060  
7065  
7070  
7075  
7080  
7085  
7090  
7095  
7100  
7105  
7110  
7115  
7120  
7125  
7130  
7135  
7140  
7145  
7150  
7155  
7160  
7165  
7170  
7175  
7180  
7185  
7190  
7195  
7200  
7205  
7210  
7215  
7220  
7225  
7230  
7235  
7240  
7245  
7250  
7255  
7260  
7265  
7270  
7275  
7280  
7285  
7290  
7295  
7300  
7305  
7310  
7315  
7320  
7325  
7330  
7335  
7340  
7345  
7350  
7355  
7360  
7365  
7370  
7375  
7380  
7385  
7390  
7395  
7400  
7405  
7410  
7415  
7420  
7425  
7430  
7435  
7440  
7445  
7450  
7455  
7460  
7465  
7470  
7475  
7480  
7485  
7490  
7495  
7500  
7505  
7510  
7515  
7520  
7525  
7530  
7535  
7540  
7545  
7550  
7555  
7560  
7565  
7570  
7575  
7580  
7585  
7590  
7595  
7600  
7605  
7610  
7615  
7620  
7625  
7630  
7635  
7640  
7645  
7650  
7655  
7660  
7665  
7670  
7675  
7680  
7685  
7690  
7695  
7700  
7705  
7710  
7715  
7720  
7725  
7730  
7735  
7740  
7745  
7750  
7755  
7760  
7765  
7770  
7775  
7780  
7785  
7790  
7795  
7800  
7805  
7810  
7815  
7820  
7825  
7830  
7835  
7840  
7845  
7850  
7855  
7860  
7865  
7870  
7875  
7880  
7885  
7890  
7895  
7900  
7905  
7910  
7915  
7920  
7925  
7930  
7935  
7940  
7945  
7950  
7955  
7960  
7965  
7970  
7975  
7980  
7985  
7990  
7995  
8000  
8005  
8010  
8015  
8020  
8025  
8030  
8035  
8040  
8045  
8050  
8055  
8060  
8065  
8070  
8075  
8080  
8085  
8090  
8095  
8100  
8105  
8110  
8115  
8120  
8125  
8130  
8135  
8140  
8145  
8150  
8155  
8160  
8165  
8170  
8175  
8180  
8185  
8190  
8195  
8200  
8205  
8210  
8215  
8220  
8225  
8230  
8235  
8240  
8245  
8250  
8255  
8260  
8265  
8270  
8275  
8280  
8285  
8290  
8295  
8300  
8305  
8310  
8315  
8320  
8325  
8330  
8335  
8340  
8345  
8350  
8355  
8360  
8365  
8370  
8375  
8380  
8385  
8390  
8395  
8400  
8405  
8410  
8415  
8420  
8425  
8430  
8435  
8440  
8445  
8450  
8455  
8460  
8465  
8470  
8475  
8480  
8485  
8490  
8495  
8500  
8505  
8510  
8515  
8520  
8525  
8530  
8535  
8540  
8545  
8550  
8555  
8560  
8565  
8570  
8575  
8580  
8585  
8590  
8595  
8600  
8605  
8610  
8615  
8620  
8625  
8630  
8635  
8640  
8645  
8650  
8655  
8660  
8665  
8670  
8675  
8680  
8685  
8690  
8695  
8700  
8705  
8710  
8715  
8720  
8725  
8730  
8735  
8740  
8745  
8750  
8755  
8760  
8765  
8770  
8775  
8780  
8785  
8790  
8795  
8800  
8805  
8810  
8815  
8820  
8825  
8830  
8835  
8840  
8845  
8850  
8855  
8860  
8865  
8870  
8875  
8880  
8885  
8890  
8895  
8900  
8905  
8910  
8915  
8920  
8925  
8930  
8935  
8940  
8945  
8950  
8955  
8960  
8965  
8970  
8975  
8980  
8985  
8990  
8995  
9000  
9005  
9010  
9015  
9020  
9025  
9030  
9035  
9040  
9045  
9050  
9055  
9060  
9065  
9070  
9075  
9080  
9085  
9090  
9095  
9100  
9105  
9110  
9115  
9120  
9125  
9130  
9135  
9140  
9145  
9150  
9155  
9160  
9165  
9170  
9175  
9180  
9185  
9190  
9195  
9200  
9205  
9210  
9215  
9220  
9225  
9230  
9235  
9240  
9245  
9250  
9255  
9260  
9265  
9270  
9275  
9280  
9285  
9290  
9295  
9300  
9305  
9310  
9315  
9320  
9325  
9330  
9335  
9340  
9345  
9350  
9355  
9360  
9365  
9370  
9375  
9380  
9385  
9390  
9395  
9400  
9405  
9410  
9415  
9420  
9425  
9430  
9435  
9440  
9445  
9450  
9455  
9460  
9465  
9470  
9475  
9480  
9485  
9490  
9495  
9500  
9505  
9510  
9515  
9520  
9525  
9530  
9535  
9540  
9545  
9550  
9555  
9560  
9565  
9570  
9575  
9580  
9585  
9590  
9595  
9600  
9605  
9610  
9615  
9620  
9625  
9630  
9635  
9640  
9645  
9650  
9655  
9660  
9665  
9670  
9675  
9680  
9685  
9690  
9695  
9700  
9705  
9710  
9715  
9720  
9725  
9730  
9735  
9740  
9745  
9750  
9755  
9760  
9765  
9770  
9775  
9780  
9785  
9790  
9795  
9800  
9805  
9810  
9815  
9820  
9825  
9830  
9835  
9840  
9845  
9850  
9855  
9860  
9865  
9870  
9875  
9880  
9885  
9890  
9895  
9900  
9905  
9910  
9915  
9920  
9925  
9930  
9935  
9940  
9945  
9950  
9955  
9960  
9965  
9970  
9975  
9980  
9985  
9990  
9995  
10000  
10005  
10010  
10015  
10020  
10025  
10030  
10035  
10040  
10045  
10050  
10055  
10060  
10065  
10070  
10075  
10080  
10085  
10090  
10095  
10100  
10105  
10110  
10115  
10120  
10125  
10130  
10135  
10140  
10145  
10150  
10155  
10160  
10165  
10170  
10175  
10180  
10185  
10190  
10195  
10200  
10205  
10210  
1021

## ABSTRACT OF THE DISCLOSURE

The present invention provides a capillary electrophoresis system comprising: a wafery part having passages filled with 5 buffer solution for introducing sample solutions; a body having a configuration suitable to removably hold and to move said wafery part attached in a relative manner, wherein said body includes: first and second electrodes for applying a voltage across both ends of passages of said wafery part to separate and take out said sample solution; and first and second buffer reservoirs conductive to said passages of said wafery part at a specific position for filling buffer solution around said first and second electrodes. The system in accordance with the present invention facilitate washing of electrophoresis passages and allows the time and labor cost required for replacement of the fused-silica wafers. The system also simplifies the operation of sample introducing to allow a plurality of sample solutions to be analyzed in a shorter time.

10  
15  
20  
25

FIG. 1

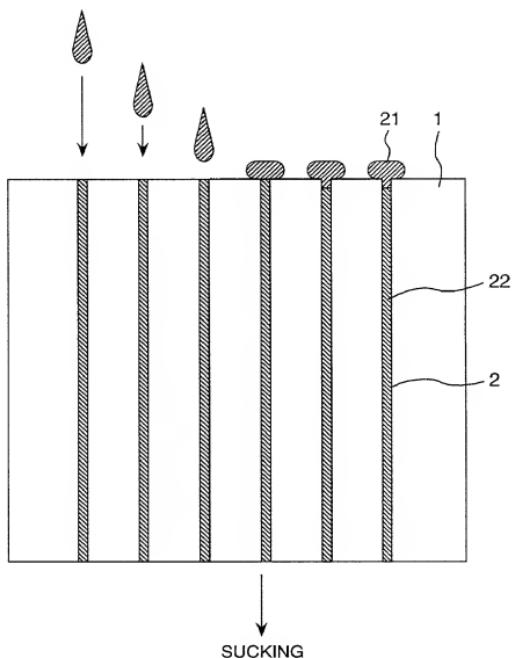


FIG. 2A

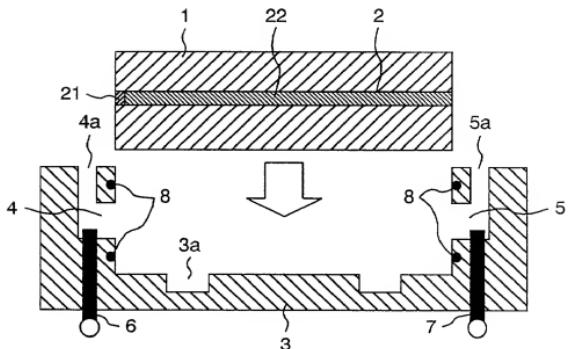


FIG. 2B

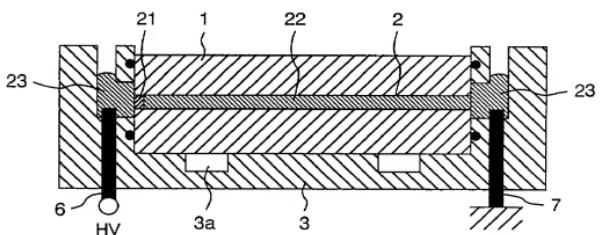


FIG. 3

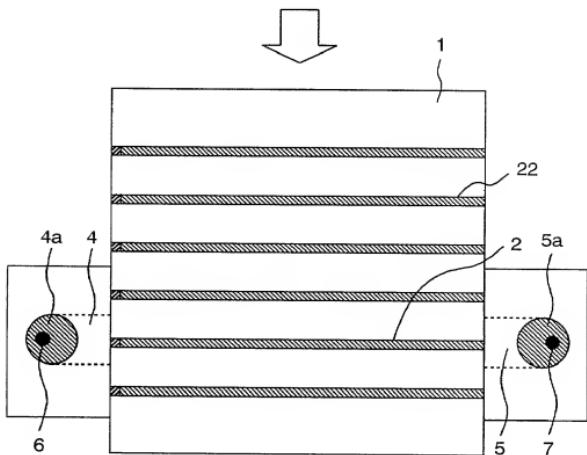


FIG. 4

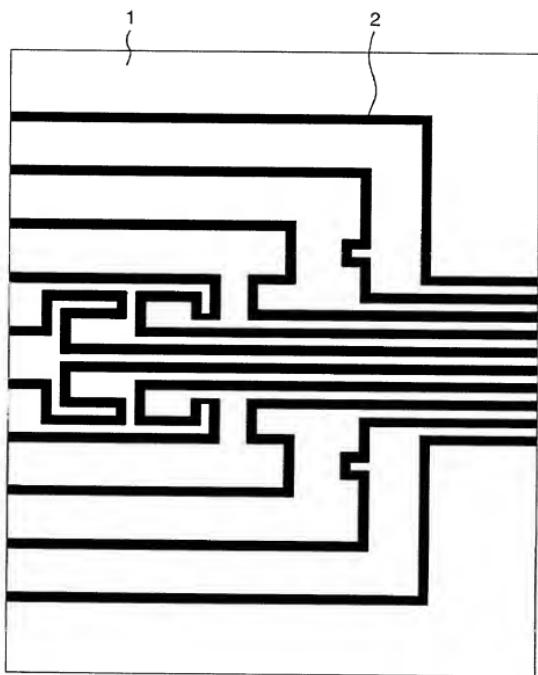


FIG. 5

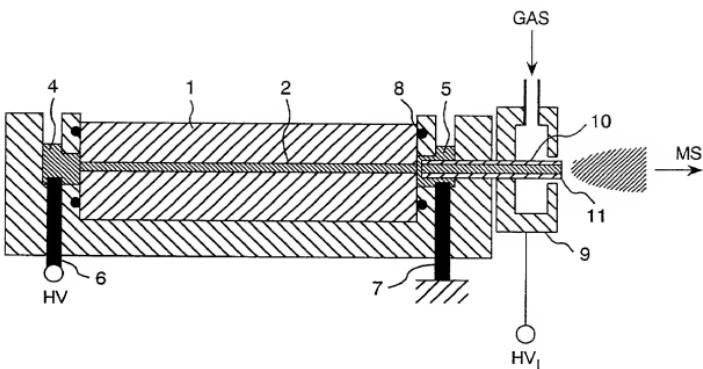


FIG. 6

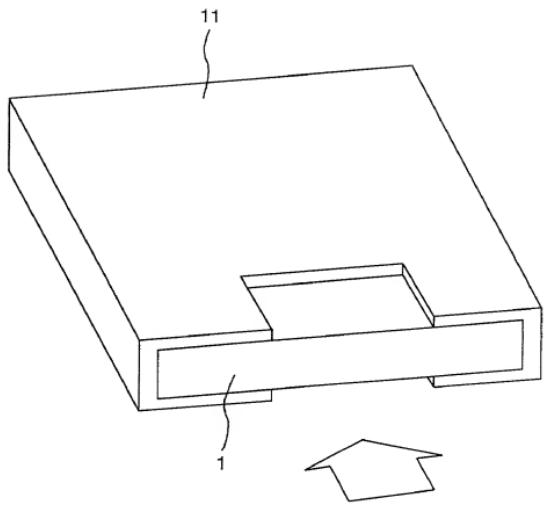
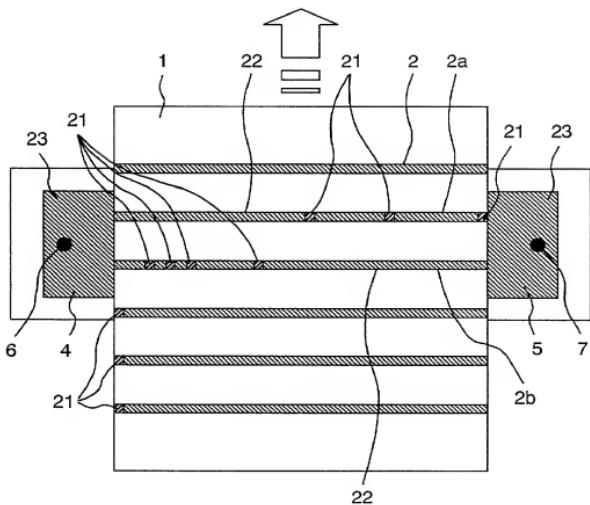


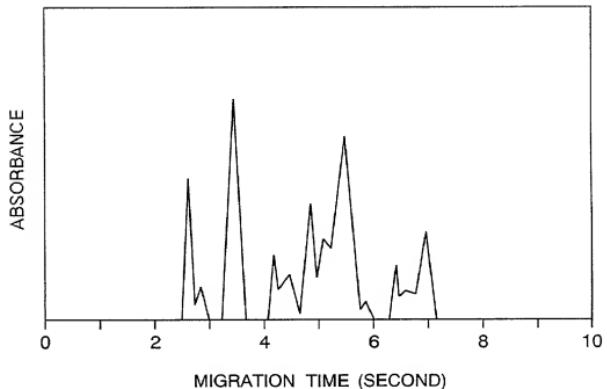
FIG. 7



09/806913

8/8

*FIG. 8*



## Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

## Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

CAPILLARY ELECTROPHORESIS SYSTEM, SAMPLE

ANALYZING SYSTEM, AND SAMPLE CASSETTE

上記発明の明細書（下記の横で×印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked:

\_\_\_\_月\_\_\_\_日に提出され、米国出願番号または特許協定条約国際出願番号を\_\_\_\_\_とし、  
(該当する場合) \_\_\_\_\_に訂正されました。

was filed on October 9, 1998  
as United States Application Number or  
PCT International Application Number  
PCT/JP98/04560, and was amended on  
\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるところ、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Japanese Language Declaration  
(日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基き下記の、米国以外の国の少なくとも一方国を指定している特許協力条約365条(a)項に基く国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

Prior Foreign Application(s)  
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	<input type="checkbox"/>
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	<input type="checkbox"/>

私は、第35編米国法典119条(e)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed  
優先権主張なし

私は、下記の米国法典第35編120条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条(c)に基く権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その後の米国出願書提出日までの期間中に入手された、連邦規則法典第37編1条56節で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)
(Application No.) (出願番号)	(Filing Date) (出願日)

(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)
(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基く表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基き、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration  
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続を米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (*list name and registration number*)

(6)

John R. Mattingly, Reg. No.30,293;  
Daniel J. Stanger, Reg. No.32,846;  
Shrinath Malur, Reg. No.34,683;  
Gene W. Stockman, Reg. No.21,021;  
Jeffrey M. Ketchum, Reg. No.31,174;  
Scott W. Brickner, Reg. No.34553;

## 書類送付先

## Send Correspondence to:

MATTINGLY, STANGER & MALUR, P. C.  
104 East Hume Avenue  
Alexandria, Virginia 22301

## 直接電話連絡先：(名前及び電話番号)

Direct Telephone Calls to: (*name and telephone number*)

Telephone: (703) 684-1120  
Fax: (703) 684-1157

## 唯一または第一発明者名

i-00

## Full name of sole or first inventor

Atsumu HIRABAYASHI

## 発明者の署名

## 日付

## Inventor's signature

Atsumu HIRABAYASHI 3/12/2001

## Date

## 住所

## Residence

Kodaira, Japan JPX

## 国籍

## Citizenship

Japan

## 私書箱

## Post Office Address

c/o Hitachi, Ltd., Intellectual Property Group  
New Marunouchi Bldg. 5-1, Marunouchi 1-chome,  
Chiyoda-ku, Tokyo 100-8220, Japan

(第二以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for second and subsequent joint inventors.)

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

第二共同発明者名		200	Full name of second joint inventor, if any
第二共同発明者の署名	日付		Yukiko HIRABAYASHI
住所			Second inventor's signature Date
国籍			<i>Yukiko Hirabayashi</i> 3/14/2001
私書箱			Residence Kokubunji, Japan JPY
第三共同発明者名		300	Full name of third joint inventor, if any
第三共同発明者の署名	日付		Akihiko OKUMURA
住所			Third inventor's signature Date
国籍			<i>Akihiko Okumura</i> 3/13/2001
私書箱			Residence Hachioji, Japan JPY
第四共同発明者名		HCO	Full name of fourth joint inventor, if any
第四共同発明者の署名	日付		Hideaki KOIZUMI
住所			Fourth inventor's signature Date
国籍			<i>Hideaki Koizumi</i> 3/15/2001
私書箱			Residence Tokyo, Japan JPY
第五共同発明者名			Full name of fifth joint inventor, if any
第五共同発明者の署名	日付		Fifth inventor's signature Date
住所			Residence
国籍			Citizenship
私書箱			Post Office Address
			c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan

09/806913  
JC02 Rec'd PCT/PTO 06 APR 2001

NIT-276  
NT0342US

LIST OF INVENTORS' NAMES AND ADDRESSES

Atsumu HIRABAYASHI, Kodaira, JAPAN;  
Yukiko HIRABAYASHI, Kokubunji, JAPAN;  
Akihiko OKUMURA, Hachioji, JAPAN;  
Hideaki KOIZUMI, Tokyo, JAPAN.